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(56) Documents cited
US 4890682 A US 4384625 A US 4058163 A

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(54) Turbine vibrator assembly

(57) A fluid driven turbine vibrator assembly comprises:

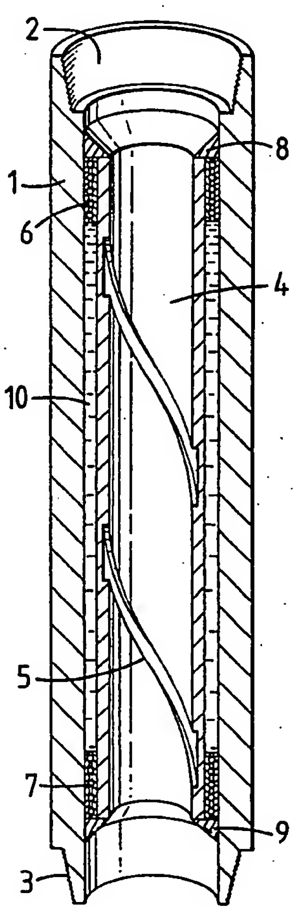
(a) an outer pressure containing stator housing 1 with end connectors 2, 3 suitable for direct attachment to other members of a drill string,

(b) an unbalanced inner full opening throughbore rotor 4 having internal blades or grooves 5, and having its longitudinal centre of mass offset with respect to its axis of rotation, and

(c) a bearing and lubricating system 6, 7, 10 which seals the rotor 4 and allows it to rotate freely within the pressure containing stator housing 1.

The assembly forms part of a drill string and reduces the incidence of stuck pipe during drilling operations or can be used to free a pipe which has become stuck.

FIG.1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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FIG.1

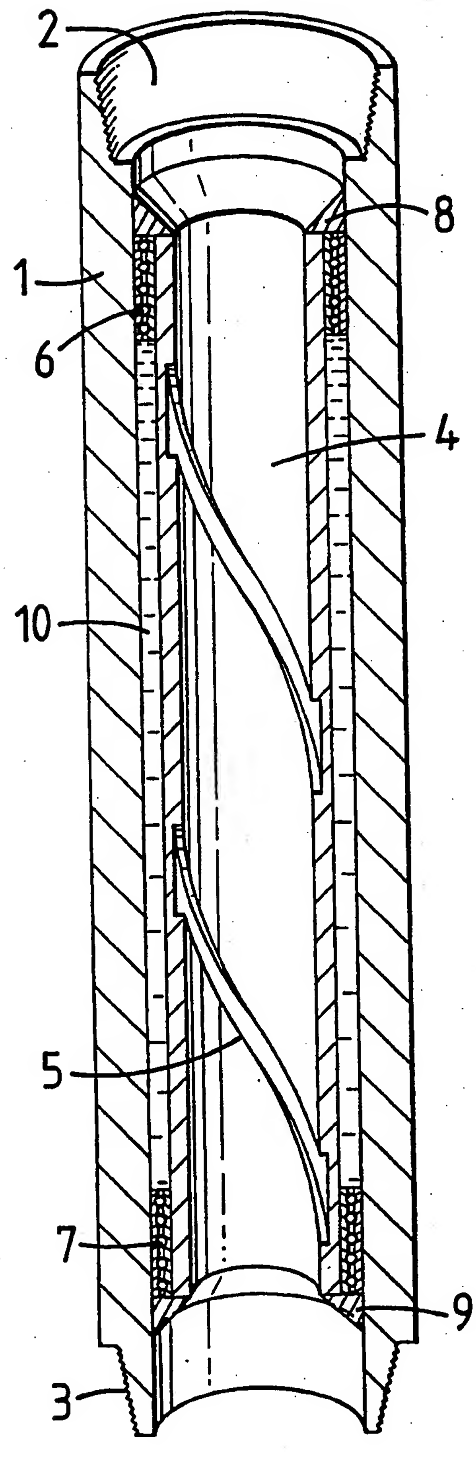
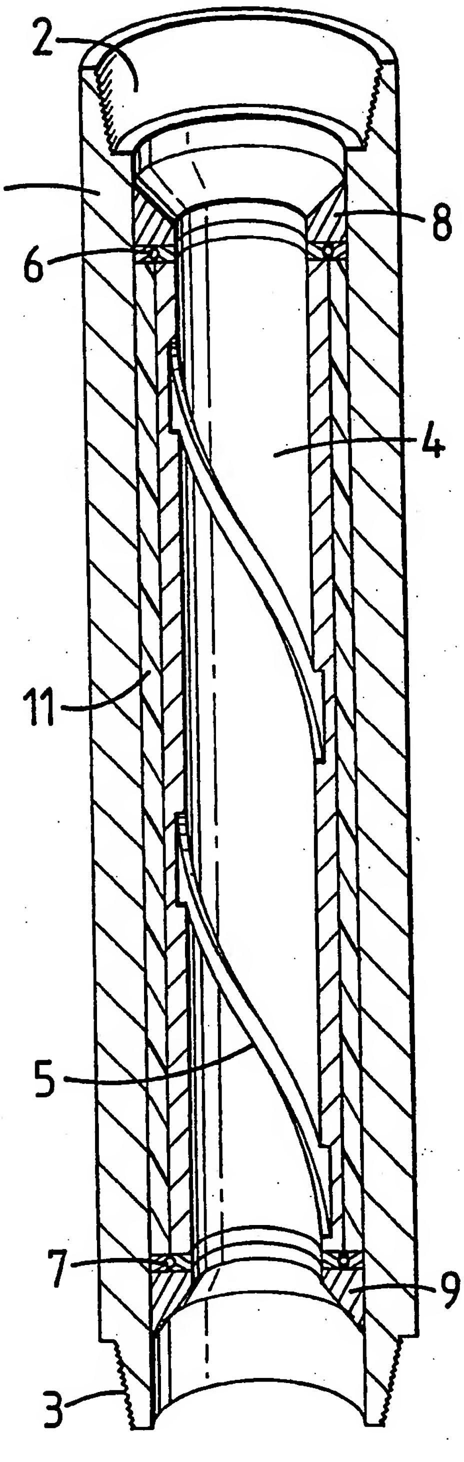


FIG.2



TURBINE VIBRATOR ASSEMBLY

This invention relates to a fluid driven turbine vibrator for reducing the incidence of stuck pipe.

Stuck pipe may be defined as drill pipe, drill collars, drill bits, stabilisers, reamers, casing, tubing, measurement while drilling tools, logging tools, etc, having inadvertently become immovable in a well bore. The term "stuck pipe" is used in the industry as a convenient compendious term to cover the sticking of all such equipment and is generally understood as not being restricted literally to pipes. Sticking may occur when drilling is in progress, when pipe or casing is being run in the hole or when the drill pipe is being hoisted.

There are numerous causes of stuck pipe; some occur regularly, some may be peculiar to a particular area and some may be unique. Industry convention categorises the causes as either differential or mechanical sticking.

Differential sticking is believed to occur by the following mechanism. During most drilling operations, the hydrostatic pressure exerted by a drilling mud column is greater than the formation fluid pressure. In permeable formations, mud filtrate flows from the hole into the rock building up a filter cake. A pressure differential exists across the filter cake which is equal to the difference between the pressure of the mud column and the pressure of the formation.

When a pipe is central in the bore, the hydrostatic pressure due to the mud overbalance acts in all directions around it. If,

however, the pipe touches the filter cake, the mud overbalance acts to push the pipe further into the cake, thus increasing the contact area between the pipe and the cake. Filtrate is still expelled from the filter cake between the pipe and the formation, thus shrinking the cake and allowing the pipe to penetrate further into it and so increasing the contact area still more. If the pressure difference is high enough and acts over a sufficiently large area, the pipe may become struck.

Differential sticking usually occurs when the pipe has been motionless for a period of time, eg when making a connection or during surveying. Differential sticking can be a particular problem when drilling depleted reservoirs because of the associated high overbalance.

The force required to pull differentially stuck pipe free depends, inter alia, upon the following factors:

(a) the difference in pressure between the borehole and the formation. Any overbalance adds to side force which may exist due to the deviation of the hole.

(b) the surface area of pipe embedded in the wall cake. The thicker the cake or the larger the pipe diameter, the greater this area is likely to be.

(c) the bond developed between the pipe and the wall cake. This is a very significant factor, being directly proportional to the sticking force. This can include frictional, cohesive and adhesive forces. It tends to increase with time, making it harder to pull the pipe free.

Differential sticking may be distinguished from other forms of sticking, such as mechanical sticking. Mud circulation is not interrupted as there is no obstruction in the hole to stop the flow, as would be the case for pipe stuck due to hole bridging or caving. It is not possible to move or rotate the pipe in any direction.

When a pipe sticks the driller usually tries to free it by mechanical movement, eg by pulling, jarring or, if the pipe was moving immediately prior to sticking, trying to move it in the opposite direction. At times this fails to release the pipe and

there is, of course, a limit to the force which can be applied, since too much force could fracture the pipe and make the situation worse.

Although stabilisers are frequently used to reduce the occurrence of differential sticking, they suffer from the disadvantage that their presence increases the risk of mechanical sticking.

Differential sticking can also be reduced by the use of a spirally grooved drill collar. This is a drill collar with a round cross-section which has a long continuous groove or flute machined helically into its outer surface. The spiralled groove provides space between the wall of the hole and the body of the collar, thus reducing the area of contact between the hole wall and collar and therefore the likelihood of differential pressure sticking.

Grooved drill collars are more expensive than conventional collars and the grooves which are not deep initially become shallower as the collar is abraded during use and eventually are worn away.

We have now devised a fluid driven turbine vibrator which reduces the incidence of stuck pipe still further.

Thus according to the present invention there is provided a fluid driven turbine vibrator assembly comprising:

(a) an outer pressure containing stator housing with end connectors suitable for direct attachment to other members of a drill string,

(b) an unbalanced inner full opening throughbore rotor having internal blades or grooves, but preferably grooves, and having its longitudinal centre of mass offset with respect to its axis of rotation, and

(c) a bearing and lubricating system which seals the rotor and allows it to rotate freely within the pressure containing stator housing.

The stator housing may be a modified length of drill pipe or drill collar having a slightly wider inner bore, if the turbine is motivated by blades, to compensate for the projection of the blades,

so that the throughbore opening of the assembly is of the same diameter as that of the other members of the drilling string. In this case it may also be advisable to increase the outer diameter slightly.

The assembly may be the length of a conventional drill pipe, ie 30 ft, but shorter subs, eg 10 ft or 6 ft, may also be effective.

As stated above, the rotor has an internal bore. If the axis of rotation of the rotor is coincident with the axis of the bore, then imbalance may be imparted by adding or removing mass asymmetrically. Alternatively the rotor may be unbalanced by locating a symmetrical rotor in such a manner that the axis of rotation is not coincident with the axis of the bore.

In either case the bore is preferably of such diameter and design to allow oil field tools run on wireline and coiled tubing to pass through the bore and into the drill string fitted below without restriction.

Wireline entry guide seals are preferably fitted immediately above and below the rotor.

The blades or grooves are preferably in the form of helical spirals.

The bearing system preferably comprises thrust bearings located between the rotor and the stator at the extremities of the rotor. If desired one or more sets of bearings can be located along the rotor to reduce the flexing of the latter.

A pressure and temperature compensated lubrication bath is preferably interposed between the walls of the stator and the rotor to allow the rotor to rotate freely within the pressure containing stator housing.

Alternatively, or additionally, a sleeve of a friction reducing material such as nylon may surround the stator.

The assembly is designed to be fitted into an otherwise conventional drill or fishing tool string.

The turbine rotor will be rotatably driven by a fluid stream, eg, a drilling mud or completion fluid, passing through the turbine at a velocity sufficient to generate vibrational energy which is

then imparted to the drill string, with the result that during drilling the drill string oscillates in a sinusoidal fashion with an amplitude which is determined by the rate of fluid flow through the rotor, the imbalance of the rotor and the design and pitch of the rotor grooves or blades.

When a sleeve is placed between the stator and the rotor, the vibrational energy transmission is increased.

The vibrational energy generated reduces the tendency for a drill string to stick in a bore hole or can be used to shake a drill string loose from a bore if the drill string sticks.

The invention is illustrated with reference to Figures 1 and 2 of the accompanying drawings which are sections of similar but differently lubricated turbine vibrator assemblies.

With reference to both Figures, the assembly comprises a pressure containing stator 1 having threaded connections 2 and 3 for connection to a drill string.

A full opening throughbore rotor 4 is rotatably mounted within the stator 1. This could have a 2 13/16" minimum ID for an 8" collar, for example or a 2¼" minimum ID for a 4¾" collar. The rotor is fitted internally with helical grooves 5 and rotates when fluid is passed down through it.

Thrust bearings 6 and 7 are mounted at either end of the rotor 4 between it and the stator 1. Additionally, wireline entry guides and seals 8 and 9 are provided at the top and bottom respectively of the rotor.

In the assembly shown in Figure 1, a pressure and temperature compensated lubrication bath 10 is interposed between the stator 1 and the rotor 4.

In the assembly shown in Figure 2, a grease lubricated nylon sleeve 11 is interposed between the stator 1 and the rotor 4.

Claims:

1. A fluid driven turbine vibrator assembly comprising:

(a) an outer pressure containing stator housing with end connectors suitable for direct attachment to other members of a drill string,

(b) an unbalanced inner full opening throughbore rotor having internal blades or grooves, and having its longitudinal centre of mass offset with respect to its axis of rotation, and

(c) a bearing and lubricating system which seals the rotor and allows it to rotate freely within the pressure containing stator housing.

2. A fluid driven turbine vibrator assembly according to claim 1 wherein the axis of rotation of the rotor is coincident with the axis of the bore and the rotor is asymmetrical.

3. A fluid driven turbine vibrator assembly according to claim 1 wherein the axis of rotation of the rotor is not coincident with the axis of the bore and the rotor is symmetrical.

4. A fluid driven turbine vibrator assembly according to any of the preceding claims wherein a sleeve is placed between the stator and the rotor.

5. A fluid driven turbine vibrator assembly according to claim 1 as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

Patents Act 1977
F ıminer's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition K) E1F (FAW, FDD, FEA)

(ii) Int Cl (Edition 5) E21B

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Search Examiner

D J HARRISON

Date of Search

11 DECEMBER 1992

Documents considered relevant following a search in respect of claims 1 TO 5

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	US 4890682 A (WORRAL et al)	1
A	US 4384625 A (ROPER et al)	1
A	US 4058163 A (YANDELL)	1

Category	Identity of document and relevant passages	Relevant to claim(s.

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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